Quantum Mechanics

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Abstract

For a long time Scientists thought that all the basic rules like gravity and movements apply to everything in nature -- but when they studied the microscopic world of atoms, electrons, and light waves, none of these things followed the normal rules. ***Quantum Mechanics,*** however, is defined as the study of *predicting behaviors of microscopic particles within the matter using mathematical formulas and measuring instruments to explore those behaviors*. This kind of study takes into consideration power and precision.

The laws of quantum came from different experiments and studies, when many physicists --like Max Planck, Niels Bohr and Albert Einstein, E. Schrodinger and others-- began to study particles, and they discovered such new physics laws.

This piece of work attempts to discuss this theory comparing the classical theory of physics to the modern theory of quantum.

Classical Theory

Looking at different objects in terms of their sizes, shapes, and substances, classical theories could only define atoms as the smallest objects. Democritus had, in fact, indicated that atoms are the building blocks of each object. However, only until the 19th century physicians could determine the size of atoms using nanotechnology to deal with atomic manipulations. The result was that atoms are as small as 0.5 nanometers.

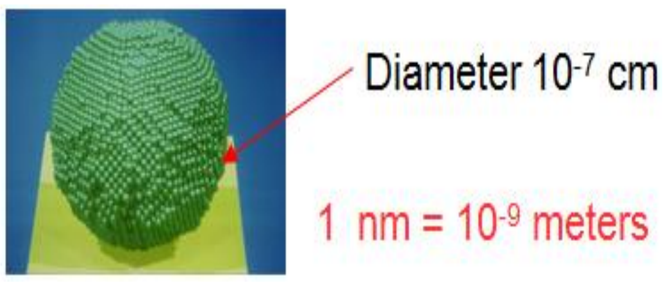


Figure 1. Descriptive picture of a big number of atoms holding each other. (1)

A. Einstein

where light hitting certain materials will create an electrical current) behaves in such a way that light must be particles with particular energy, not continuous waves.
Particles of light are called light quanta or photons. Packet of energy in photon is so small that we are not aware of the rain of photons of light impinging on our eyes.

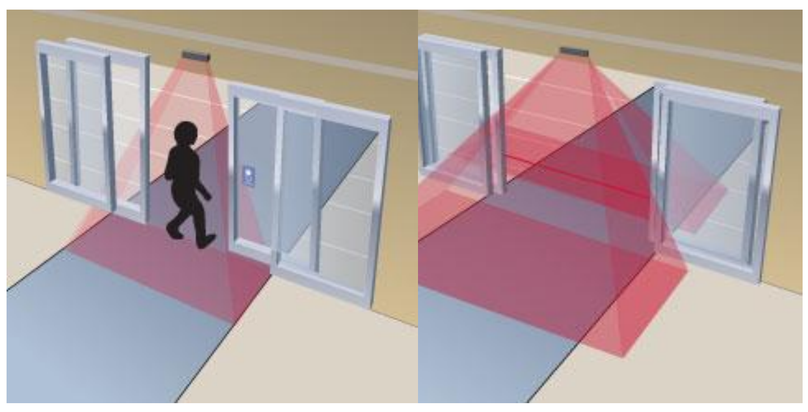


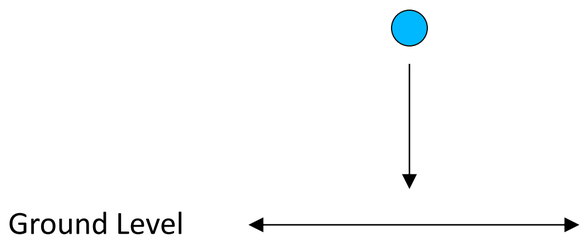
Figure 3. Full presence detection in the automatic doors through photo-electric effects(2)

Quantum Theory

Basically, the theory looks up the different behaviors of atom, electrons, photons etc… in a given situation.

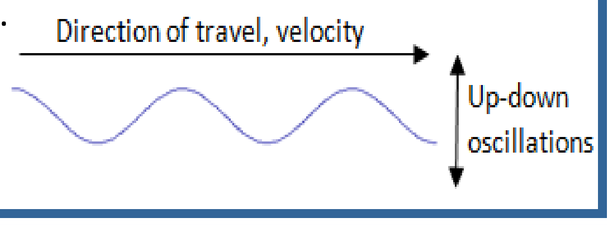
Wave/Particle Duality

- ***Particles***: Material objects as a Ball, Car, person, or any point like objects called particles.



Results: Particles can be located at a space point at a given time in a rest, moving or accelerating. If an electron traveling around a nucleus behaves like a wave.

-***Waves***: There are many types of waves like ripples, surf, ocean waves, sound waves, or radio waves. They are oscillations in space and time defined by their length, frequency, velocity and oscillation size.



Max Planck

Energy is quantized- an electron in an atom is only "allowed" to have certain amounts of energy, or to be at certain distances from the nucleus- not in between.

Result: Light wasn't really a continuous wave as everyone assumed. This could not be explained within the classical theory of physics, so Planck concluded that the laws of classical physics do not apply to atoms.

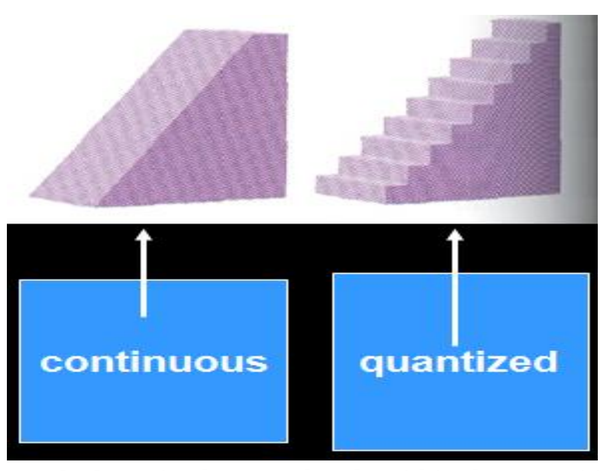


Figure 3. Quantized energy levels within the atom.(3)

Differences

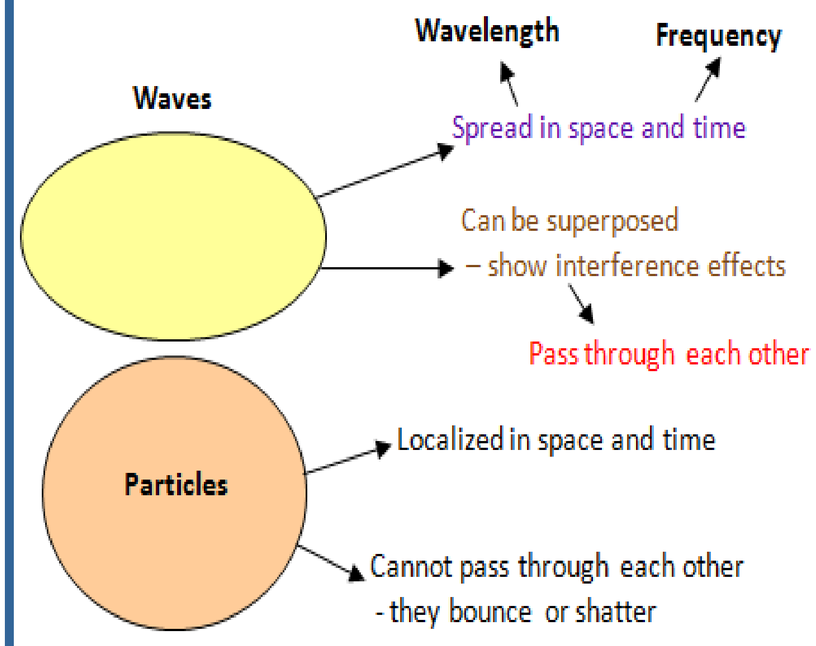


Figure 4. Wave/Particle differences

N. Bohr Revolutionary Model

This model was that electrons can only travel in fixed orbits around the nucleus, so when electrons move from a higher orbit to a lower one they emit radiation with a fixed amount of energy.

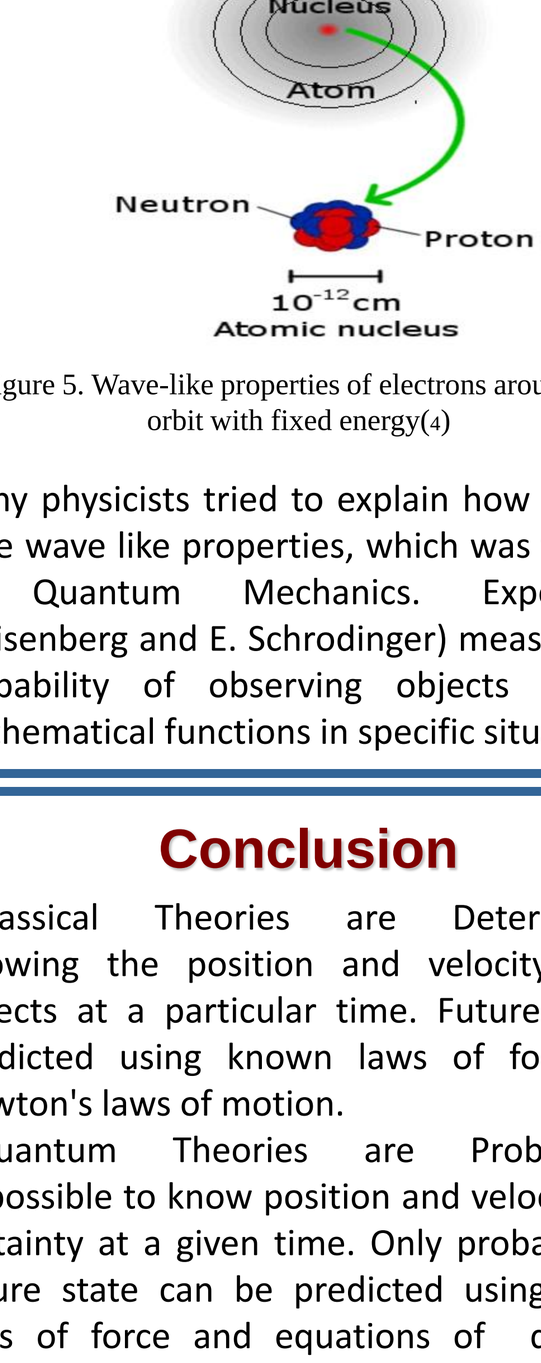


Figure 5. Wave-like properties of electrons around the orbit with fixed energy(4)

Many physicists tried to explain how particles have wave like properties, which was the start of Quantum Mechanics. Experiments (Heisenberg and E. Schrodinger) measured the probability of observing objects using a mathematical functions in specific situations.

Conclusion

- Classical Theories are Deterministic: Knowing the position and velocity of all objects at a particular time. Future can be predicted using known laws of force and Newton's laws of motion.
- Quantum Theories are Probabilistic: Impossible to know position and velocity with certainty at a given time. Only probability of future state can be predicted using known laws of force and equations of quantum mechanics.
- Duality of Nature: All physical objects exhibit both particle and wave like properties.
- Before observation it is impossible to tell whether object is a wave or a particle or whether it exists at all.

References:

- **Birman, F. (2009). Quantum mechanics, correlations, and relational probability. *Crítica, 41*(121), 3(20)**
- **Moyal, J. E. (1949). Quantum mechanics as a statistical theory. *Mathematical Proceedings of the Cambridge Philosophical Society, 45*(01), 99-124.**

Pictures Sources:

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(2) http://www.nabcoentrances.com/sensor_detection_patterns.cfm
(3) http://www.theory-of-evolution.net/chap6/quantum-mechanics-8.php